



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water Office

Water Management Plan

Chapter 3.11 – Victorian Rivers

2020–21



This document represents a sub-chapter of 'Commonwealth Environmental Water Office Water Management Plan 2020-21, Commonwealth of Australia, 2020'.

Please visit: <https://www.environment.gov.au/water/cewo/publications/water-management-plan-2020-21> for links to the main document.

Acknowledgement of the Traditional Owners of the Murray–Darling Basin

The Commonwealth Environmental Water Office respectfully acknowledges the Traditional Owners, their Elders past and present, their Nations of the Murray–Darling Basin, and their cultural, social, environmental, spiritual and economic connection to their lands and waters.

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3.11 Victorian Rivers

3.11.1 Region overview

(a) River system

The Victorian rivers in the Murray-Darling Basin include the Goulburn-Broken, Campaspe, Loddon, Ovens and Wimmera catchments (**Error! Reference source not found.** and Figure 2). The northern Victorian rivers, particularly the Ovens and Goulburn-Broken, contribute significantly to the water resources of the River Murray, and 11.5 per cent of the Basin's stream flow originates in the Goulburn-Broken. Lake Eildon on the Goulburn River is one of the Basin's major water storages. The Wimmera River in central-west Victoria flows into a series of terminal lakes, including Hindmarsh and Albacutya and does not connect to the River Murray. The Victorian rivers region has a highly developed agricultural sector and a population of almost half a million people (DEPI 2015).

(b) Traditional Owners

Aboriginal people have had a long association with the river valleys of northern and central Victoria (MDBA 2020):

- The Ovens River catchment falls in the traditional lands of the Bangerang nation and neighbouring Taungurung and Yorta Yorta nations, to the south and west, respectively. The Waywurru nation is also located within the Ovens River valley.
- The Aboriginal people of the northern plains of the Goulburn and Broken catchments are the Yorta Yorta and Bangerang Nations. The Taungurung is the main Nation of people in the Broken River Valley and upper Goulburn Valley.
- West of the Campaspe River is the traditional land of the Dja Dja Wurrung Nation and east is the land of the Taungurung Nation. On the plains north of Rochester, the area is the traditional land of the Yorta Yorta and Bangerang Nations.
- Most of the Loddon catchment and the Avoca catchment is the traditional land of the Dja Dja Wurrung Aboriginal nation. On the floodplains, around Kerang and Kow Swamp, is the traditional land of the Barapa Barapa nation.
- The Wimmera catchment is large and diverse, and covers the traditional country of several Aboriginal Nations, including the Dja Dja Wurrung, Wotjobaluk and Wergaia in the mid and lower catchment. The north of the catchment, towards the River Murray, is the traditional lands of the Latji Latji, Tatti Tatti and Wamba Wamba Nations.

(c) Important sites and values

The northern Victorian Rivers are identified in the Basin-wide environmental watering strategy (MDBA 2019) as being important Basin environmental assets for native fish, including supporting threatened native fish species, high fish diversity, and as a fish refuge during dry periods. They create key native fish movement corridors and are recognised as priority sites for improving the core range of silver perch.

These rivers also support species and communities listed under the *Environment Protection and Biodiversity Conservation Act 1999*. Faunal species include Murray cod, Macquarie perch, trout cod, silver perch, Australasian bittern, swift parrot and the growling grass frog; vegetation includes rigid water milfoil and box-dominated grassy woodland communities.

The river system also supports bird species listed under international migratory species agreements (such as those agreements with Japan, China and the Republic of Korea, and the Bonn Convention), including the Caspian tern, glossy ibis and Latham's snipe.

Located at the terminus of the Wimmera system, Lake Albacutya Ramsar wetland represents the only internationally listed wetland along the northern Victorian river reaches, but only receives water in exceptionally wet years. Further, the Kerang Wetlands Ramsar site is located at the junction of three major floodplains associated with the Avoca, Loddon and Murray rivers, and is hydrologically linked to the Loddon River. Several sites are listed in the Directory of Important Wetlands in Australia including the Broken River, Upper Broken Creek, Lower Ovens River, Wimmera River, Lake Hindmarsh and Moodie Swamp.

The delivery of environmental water to the northern Victorian rivers also supports ecological values and outcomes in the River Murray valley. This can include Ramsar-listed wetlands such as Barmah Forest, Gunbower Forest, Hattah Lakes, and the Coorong, Lower Lakes and Murray Mouth.

(d) Partners and Stakeholder engagement

The planning, management and delivery of Commonwealth water for the environment throughout the northern Victorian valleys is undertaken in collaboration with a range of partners and stakeholder groups.

The implementation of watering actions within the Victorian rivers is coordinated by the Victorian Environmental Water Holder (VEWH) and managed by regional waterway managers including the Goulburn-Broken Catchment Management Authority (GBCMA), North Central Catchment Management Authority (NCCMA), North East Catchment Management Authority (NECMA) and Wimmera Catchment Management Authority (WCMA). Goulburn Murray Water (GMW) is the principal storage and water supply manager in northern Victorian catchments and is responsible for the day to day delivery of water (including environmental water) throughout its river systems and irrigation supply network. Grampians Wimmera Mallee Water (GWMW) is the storage and water supply manager for the Wimmera catchment.

Early input to the potential watering actions for 2020–21 was received via the Environmental Watering Advisory Group meetings organised and chaired by the North Central and Goulburn Broken Catchment Management Authorities. In addition to relevant government agencies, membership includes local land holders, irrigators and community members. The Yorta Yorta, Taungurung and Dja Dja Wurrung Nations are invited to contribute to the development of these actions, to embed cultural values and Traditional Owners ecological knowledge into environmental water management. Delivery partners and the Catchment Management Authorities attended workshops to review the 2019–20 watering events, including to identify any risks that arose, and discuss mitigating actions going into 2020–21. Feedback on draft versions of the plan was provided by the Victorian Environmental Water Holder and the Catchment Management Authorities and incorporated into the final version.

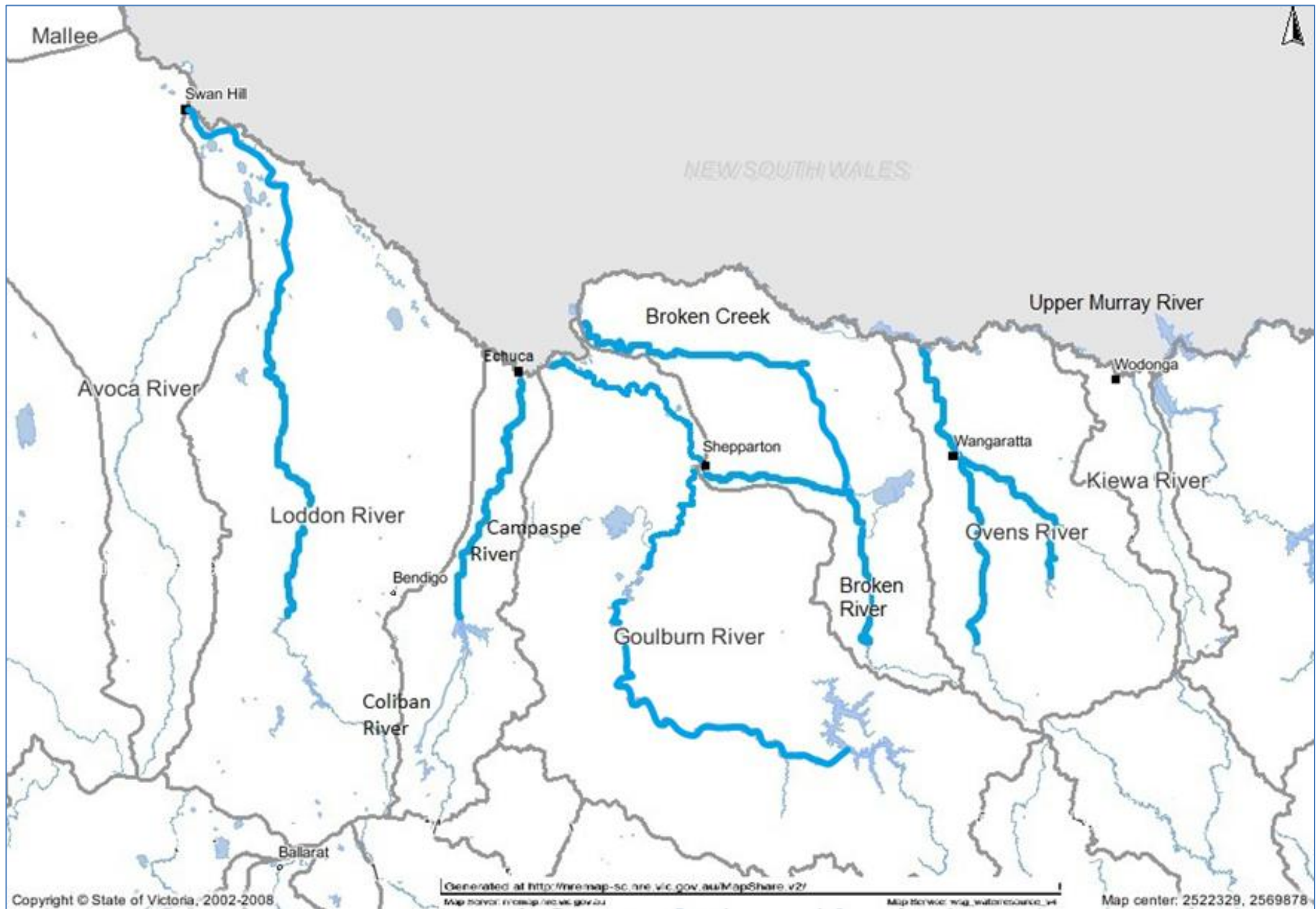


Figure 1: Map of the northern Victorian rivers described in this plan that flow to the River Murray.



Figure 2: Map of the Victorian Wimmera System

3.11.2 Environmental objectives

The following objectives in Table 1 are relevant for environmental watering in Victorian Rivers. They are based on long-term environmental objectives in the Basin Plan, Victorian state government long-term watering plans for northern Victorian catchments, site management plans, and best available knowledge.

The objectives that are targeted in a particular year may vary, depending on available water, catchment conditions, operational feasibility, and demand for environmental water. These objectives will continue to be revised as part of the Commonwealth Environmental Water Office’s (CEWO) commitment to adaptive management.

Table 1: Summary of objectives being targeted by environmental watering in the Victorian rivers

Basin-wide Matters	In-Channel Assets	Off-Channel Assets
Vegetation	<ul style="list-style-type: none"> Maintain and improve riparian and in-channel vegetation cover, extent, condition and diversity. Increase periods of growth for inundation tolerant vegetation communities that closely fringe or occur within river channels. 	<ul style="list-style-type: none"> Maintain the current extent, condition and diversity of water-dependent vegetation. Improve condition of black box, river red gum and lignum shrublands. Improve recruitment of trees within black box and river red gum communities.
Waterbirds	<ul style="list-style-type: none"> Provide habitat and food sources to support waterbird breeding, survival and recruitment, and maintain condition and current species diversity. 	<ul style="list-style-type: none"> Support waterbird breeding, including brolga in Moodie Swamp
Fish	<ul style="list-style-type: none"> Provide flows to support habitat and food sources to promote increased movement, breeding, recruitment and survival of native fish. Improve abundance and maintain species richness. Provide native fish passage through fishways. 	<ul style="list-style-type: none"> Provide flow cues to support habitat and food sources and promote increased movement, recruitment and survival of native fish (particularly for floodplain specialists).
Invertebrates	<ul style="list-style-type: none"> Provide habitat to support increased microinvertebrate and macroinvertebrate survival, diversity, abundance and condition. 	
Other Vertebrates	<ul style="list-style-type: none"> Provide habitat and food sources to support survival, maintain condition and provide recruitment opportunities for frogs, turtles, platypus and native water rats (Rakali). 	

Basin-wide Matters	In-Channel Assets	Off-Channel Assets
Connectivity	<ul style="list-style-type: none"> Support longitudinal connectivity along Victorian rivers and to the River Murray for environmental functions such as nutrient and sediment transport, organism dispersal and water quality. Support lateral connectivity to low-lying wetlands and anabranches adjacent to river channel by increasing the frequency of freshes. 	<ul style="list-style-type: none"> Support lateral connectivity (within operational limits) to wetlands and floodplains by contributing to an increase in the frequency of lowland floodplain flows.
Processes	<ul style="list-style-type: none"> Support primary productivity, sediment, nutrient and carbon transport and cycling; biotic dispersal/movement; and channel maintenance. 	
Water Quality	<ul style="list-style-type: none"> Maintain water quality and provide refuge habitat from adverse water quality events (e.g. low dissolved oxygen, hypoxic blackwater and hypersalinity), including minimising accumulation of Azolla (aquatic plant) in lower Broken Creek to help maintain DO levels. 	<ul style="list-style-type: none"> Support the transport of nutrients and carbon off the floodplain and into the river channel and downstream.
Resilience	<ul style="list-style-type: none"> Provide drought refuge habitat. 	

3.11.3 First Nations Environmental Objectives

Advice on environmental water objectives in the Victorian Rivers has been provided by the Murray Lower Darling Rivers Indigenous Nations (MLDRIN) through the First Nations Environmental Water Guidance project.

Table 2 includes just some of the common objectives for the Victorian River catchments, selected as they were raised by two or more participating Nations for the region. It is important to note these objectives do not represent the detail, depth and complexity of Nations' localised water-related objectives.

Some of these objectives sit outside the scope of water for the environment to influence, while for others, the link between water for the environment and the site or issues is not well understood. Environmental flows will aim to contribute to identified objectives, where possible. The Commonwealth Environmental Water Office is committed to continuing to strengthen engagement with all Southern Basin First Nations to support those Nations to articulate objectives for water management.

Table 2: First Nations environmental water objectives for Victorian Rivers for 2020-21 (MLDRIN 2020)

Waterways and Places in Need of watering
Wetlands, Billabongs, Floodplains, Creeks, Major rivers, Campaspe River, Ramsar-listed wetlands, Baaka, Murray.
River Flows and Connectivity
Improve water quality, improve timing and seasonality of flows, Restore wetland hydrology, Improve river and or floodplain connectivity, Improve flows and quantity (rivers and general), Remove barriers and constraints, Improve tributary flows, Restore flows in degraded rivers.
Vegetation
Cumbungi, Medicinal plants (general) ⁱ , Old Man Weed, River Red Gum, Black Box, Black Wattle ⁱ
Fish
Native fish (all), Murray Cod, Catfish, Yellowbelly, Blackfish, Macquarie Perch, Silver perch
Waterbirds
Brolga, Birds, Pelican
Other species
Turtles, Yabbies, Frogs (general), Platypus, Water Rat (Rakali), Murray Cray, Shrimp, Emu ⁱ , Macroinvertebrates.

ⁱ Water for the environment targeting other environmental outcomes may influence this species or objective

3.11.4 Recent conditions and seasonal outlook

(a) *Recent conditions and environmental water use*

The health of the Victorian rivers in the Murray-Darling Basin reflect the climate conditions of the past 20 years. During this period there was prolonged drought conditions between 1997 and 2010. Since the Millennium Drought, three natural high river flow events have occurred (2010-11, 2012-13 and 2016-17) which provided overbank flooding and large flow volumes for many northern Victorian catchments. The years between the floods, and since the 2016 flood, have been moderate or dry. Environmental watering in northern Victoria has focused on supporting year-round baseflows along with higher in-channel flows (such as freshes) in winter and spring. This has contributed to positive ecological outcomes such as maintaining vegetation condition along riverbanks and riparian zones, improved water quality and providing habitat for water bugs and native fish. However, in the last three years large volumes of operational water have been delivered over the summer months in the Campaspe and Goulburn Rivers to meet the need of downstream users (known as inter-valley transfers). This has caused some erosion and damage to vegetation on the lower parts of the riverbanks in these catchments.

Ongoing dry conditions across the northern Victorian catchments mean that many of the sites continue to require water for the environment to maintain the ecological health of the waterways and have high demand, as outlined in Table 3.

Details of previous Commonwealth environmental use in Victorian Rivers are available at: <http://www.environment.gov.au/water/cewo/catchment/northern-victorian-rivers/history>.

(b) Seasonal outlook

According to the Bureau of Meteorology outlook (BoM 2020), across northern Victoria there is largely a 60-80 per cent chance of above median rainfall from June to August 2020.

While this forecast indicates that the severe dry conditions may ease somewhat, several months of above average rainfall are needed to see a recovery from the current long-term drought. Additionally, maximum temperatures are likely to remain slightly below average from June to August.

(c) Water availability

Allocations against Commonwealth water entitlements in the Victorian rivers are determined by the Victorian Government and will vary depending on inflows. The following forecasts in Table 3 are based on the best available information including state forecasts and historical inflow scenarios.

Table 3: Carryover and forecast allocation of Commonwealth environmental water for Victorian rivers in 2020-21

Valley	Carryover from 2019-20 (GL)	Forecasts of Commonwealth water allocations (including carryover) in 2020–21 (GL)	
		Very dry	Very wet
Goulburn	55.2	198.8	372.8
Upper Broken Creek and Broken River	0.1	0.1	0.5
Campaspe	0.4	0.7	7
Loddon	0	1.1	3.4
Ovens	0	0.1	0.1
Wimmera	0	0	0
Total – Southern-connected Basin ¹	267	821	1 829

(d) Environmental demands

Not all environmental demands can and will be met using held environmental water. Some demands are met by regulated water deliveries for consumptive purposes and inter-valley transfers, while others are met by large unregulated/natural flow events or are beyond what can be delivered within current operational limits. There may be opportunities for Basin State governments to relax these limits, which will improve the efficiency and/or effectiveness of environmental watering.

The environmental water demands for assets in Victorian Rivers in 2020-21 are represented in **Table 4**. Note that the capacity to contribute to these environmental demands is contingent on a substantial improvement in water availability in the catchment.

¹ Southern-connected Basin is the network of rivers that feed into the Murray River between the Hume Dam and the sea. This includes the Murray, Murrumbidgee, Lower Darling, Ovens, Goulburn-Broken, Campaspe and Loddon valleys.

Table 4: Environmental demands, priority for watering in 2020-21 and outlook for coming year in Victorian Rivers.

For northern Victorian Rivers a flow range is provided for each potential watering action. This allows for flexibility of delivery across the year depending on water availability which can range between Very Low, Low, Moderate, High and Very High. For example, volumes at the lower end of range and/or shorter duration during dry conditions and an increased magnitude and/or duration and/or additional freshes as resource availability increases. In all rivers it is aimed to have some flow all year-round, with no cease flow experienced.

The information in this table is consistent with the draft VEWB Seasonal Watering Plan (VEWB 2020) and the relevant CMA Seasonal Watering Proposals (GBCMA a-d 2020; NCCMA a, b 2020; NECMA 2020; WCMA 2020).

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21
<p>Goulburn River reach 4 Goulburn Weir to Loch Garry; and reach 5 Loch Garry to the River Murray</p> <ul style="list-style-type: none"> • Native fish - Murray cod, trout cod, Macquarie perch, golden perch and fresh water catfish • Bank vegetation, especially littoral vegetation and river red gum trees that shade the river and provide: habitat for animals including the squirrel glider; carbon from fallen leaves; habitat for birds such as egrets, herons and cormorants. • Frogs also benefit from inundated vegetation at the edge of the river channel. • Waterbugs <p>During the past two years very high volumes of intervalley transfer water has impacted on the planned deliver of e-water and this may continue during 2020-21 if dry conditions continue.</p>	<p>Low flow (all year)</p> <p>500-940 ML/day to: provide slow shallow habitat for small-bodied fish and deep water habitat for large-bodied fish; submerge snags to provide habitat for fish, waterbugs and biofilm growth; maintain aquatic vegetation and water the root zone of vegetation on the lower bank; encourage the production of plankton for food; and disrupt biofilms and maintain water quality.</p>	<p>Annually with all levels of water availability</p>	<p>Minimum low flows have been delivered every year since the Millennium drought.</p>	<p>High</p>	<p>High priority for Commonwealth environmental water. However likely to be met by other water sources such as natural or operational flows for large parts of the year.</p>	<p>High</p>
	<p>At least one winter/spring fresh (July-Oct)</p> <p>>6 600 ML/day for 14 days for lower bank vegetation establishment and maintenance. Deliver using tributary flows where possible, rather than releases from Eildon.</p> <p>If there is no natural event then deliver as a managed event in Sept/Oct to inundate vegetation on benches and the lower banks to facilitate recruitment, sustain growth, and encourage flowering, seed development and distribution.</p>	<p>Annually except</p>	<p>An early spring flow was delivered in 2012-13, not delivered in 2013-14 and partially met during 2014-15 and 2015-16. Since then, LTIM has identified the early spring fresh as important to deliver each year. This demand has been met every year since 2016-17, including in 2019-20.</p>	<p>High</p>	<p>High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)</p>	<p>High</p>
	<p>Spring/summer low flow (after a spring fresh)</p> <p><1 000 ML/day for 5–6 weeks to allow newly grown plants to establish, provide bank stability and provide habitat for small-bodied fish and waterbugs.</p>	<p>Annually with all levels of water availability</p>	<p>This was partially achieved in 2019-20, the first year it was included as a flow requirement. IVT flows commenced four weeks into this period and exceeded the recommended flow.</p>	<p>This is a demand to <u>not</u> provide water above a given flow rate</p>		<p>High due to vegetation damage caused by prolonged IVT flows in previous years</p>
	<p>Spring/summer fresh (Nov/Dec)</p> <p>When possible, >6 600 for 1 day for native fish spawning.</p> <p>This will not be delivered if the spring/summer 5-6 weeks low flow for vegetation has not been achieved.</p>	<p>When conditions are suitable except with Very Low water availability</p>	<p>A late spring fresh was delivered from 2012–13 to 2014–15 but with dry conditions in 2015–16 it was not delivered. In 2016–17 fish spawning objectives were met by natural flows so the fresh was not delivered to protect low bank vegetation after prolonged periods of high natural flows. It was delivered in 2017–18 but not in 2018–19 and 2019–20 due to the need for a drying phase for bank vegetation ahead of expected higher summer operational flows.</p>	<p>High if a decision is made for the action to be delivered</p>	<p>High priority for Commonwealth environmental water if a decision is made for the action to be delivered</p>	<p>High</p>

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21
Goulburn River continued <i>(reaches 4 and 5)</i>	Summer/autumn low flows between pulses. Flows are not to exceed 1 000 ML/day for more than 20 consecutive days, with a minimum of 7 days between pulses. This is to maintain vegetation for more than one season, to provide bank stability and to ensure habitat for small-bodied fish and waterbugs. This flow is a trigger for the delivery of an autumn fresh – i.e. if this flow objective is not met, the autumn fresh will not be delivered.	Annually with all levels of water availability	This objective has not been met since 2016.	This is a demand to <u>not</u> provide water above a given flow rate		High
	Autumn fresh (March/April) When possible >5 600 ML/day for 2 days to: encourage seed germination; reduce turbidity and mix water to improve water quality; flush fine sediment to encourage biofilm growth; and improve food and habitat for waterbugs. Note that delivery of the summer/autumn low flows between pulses is a trigger for this action.	Annually when possible and with all levels of water availability	This autumn fresh was delivered from 2012–13 to 2015–16. It was not delivered in 2016–17 or 2017–18 following the earlier fish attractant flow action in those years. This fresh was not delivered in 2018–19 due to the already high volumes delivered as intervalley transfers and in 2019–20 due to dry conditions and low water availability.	Moderate – this demand is only triggered under certain scenarios	Option to be considered only under certain conditions	Moderate
	Winter fresh (June/July 2021) Up to 15 000 ML/day [†] with more than 14 days above 6 600 ML/day to: encourage bank vegetation; provide carbon (e.g. leaf litter) to the channel; and improve water quality and waterbug habitat. The winter fresh also has direct benefit for lamprey migration in South Australia if deliver to the Lower Lakes during July and/or August.	Annually except with Very Low water availability	The winter fresh was first delivered in 2014–15, then not delivered in 2015–16 due to low water availability. It was delivered in each year between 2016–17 and 2018–19 but not in 2019–20 due to low water availability.	Moderate	High priority for Commonwealth Environmental water, however this action may be met/partially met by natural flows	High
	Following natural flows (all year) Provide water for a slower recession or add pulses following natural cues/unregulated flows to minimise the risk of bank erosion and hypoxic blackwater. Recession flows are releases from Goulburn Weir to prevent damage to the lower bank for 3 000 ML/day and below in Summer/Autumn and 6 000 ML/day in Winter/Spring	When required	The delivery of environmental water to slow a recession occurred twice in 2019–20.	High when required	High priority for Commonwealth environmental water if triggered from natural inflow events – this could occur under any scenario	High when required
Goulburn River reach 1 Lake Eildon to Goulburn Weir • Native fish - Macquarie perch Only receives water when it is released from Lake Eildon	Spring/autumn/winter low flows (July–Sept and April–June). 400 ML/day at Eildon to maintain and improve the habitat of small bodied native fish and maintain existing aquatic vegetation and invertebrate communities.	Annually during the non-irrigation month with all levels of water availability	This low flow was delivered during the non-irrigation period each year between 2017–18 and 2019–2.	High	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	High

[†] Note the peak flow achievable with environmental water under current operating rules is approximately 9 500 ML/d in the lower Goulburn. The full target flow of 15 000 ML/d can however be met with unregulated tributary inflows.

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands	
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21	
<p>Lower Broken Creek reach 4 Nathalia Weir to River Murray with en route benefit to reach 1 (Boosey Creek to Nine Mile Creek), reach 2 (Nine Mile Creek) and reach 3 (Broken Creek confluence with Nine Mile Creek to Nathalia Weir).</p> <ul style="list-style-type: none"> • Native fish – Murray cod, golden perch, silver perch, unspoked hardyhead and Murray-Darling rainbow fish • Platypus, turtles, water rat (Rakali) • Vegetation – box-dominated grassy woodland communities, river swamp wallaby-grass • Birds – Australian Bittern • Environmental demand requires water in addition to irrigation supply • Source of return flows for use downstream in the River Murray <p>During the past two years very high volumes of intervalley transfer water has impacted on the planned delivery of environmental water and this may continue during 2020–21 if dry conditions continue.</p>	<p>Year-round low flow</p> <p>A minimum of 40 ML/day to allow fish ladders to remain open, enable native fish movement and provide minimum levels of habitat for platypus, water rat (rakali), fish, plants, waterbugs and turtles.</p>	<p>Annually with all levels of water availability</p>	<p>The year-round flow of 40 ML/day is considered the minimum requirement and has been met or partially achieved since 2011-12. Environmental water has been the main water source used to provide minimum low flows during the non-irrigation season, especially in dry years.</p>	<p>High</p>	<p>High during the non-irrigation season. Likely to be met by operational deliveries during the irrigation season.</p>	<p>High</p>	
	<p>Year-round (during irrigation season) higher flows</p> <p>300–450 ML/day delivered when required for operational purposes. These levels are not expected to cause negative ecological outcomes.</p>		<p>This flow has been partially achieved each year since 2011-12. In recent years, Inter-Valley Transfers and Murray Bypass flows have been the main water source contributing to higher flows during the irrigation season.</p>				<p>Moderate</p>
		<p>Year-round (during irrigation season) extended high flow (July to May)</p> <p>100–250 ML/day</p> <p>250 ML/day over spring and summer to help prevent Azolla accumulation and maintain dissolved oxygen (DO) levels, and reduced flow at other times to maintain instream habitat for native fish spawning and movement.</p>	<p>Annually if required with all levels of water availability</p>	<p>Extended high flows have been met or partially achieved since 2011-12 through a combination of environmental water and consumptive deliveries. In recent years, Inter-Valley Transfers and Murray Bypass flows have significantly contributed to the provision of extended high flows.</p>	<p>High</p>	<p>High priority for Commonwealth Environmental water, however this action may be partially met by operational flows</p>	<p>High</p>
		<p>Winter/spring freshes (July–Sept)</p> <p>Up to 3 actions of 300-450 ML/day for 1 to 2 weeks to flush Azolla blooms (if any) and to provide cues to trigger fish migration, spawning and dispersal.</p>	<p>Annually if required with all levels of resource availability water</p>	<p>Freshes have been met in most years since 2011-12 and partially achieved in others. Environmental water deliveries have contributed significantly to the provision of spring freshes.</p> <p>A late winter/spring fresh through environmental water delivery was not required in 2019-20 as Azolla levels remained low.</p>	<p>High when required</p>	<p>High priority for Commonwealth Environmental water, however this action may be met/partially met by natural flows</p>	<p>High</p>
<p>Goulburn-Broken catchment wetlands (Moodie Swamp)</p> <p>Accessed via Gearys channel from reach 2; Waggarandall Weir to Reillys Weir</p> <ul style="list-style-type: none"> • Birds – Brolga • Native vegetation - cane grass and rigid water milfoil 	<p>Spring – a top-up if required to support bird breeding and plant growth/flowering</p> <p>Autumn – fill</p> <p>Delivery is to promote growth of cane grass to provide habitat for brolga nesting and for rigid water milfoil germination and growth.</p>	<p>Moodie Swamp maximum dry interval is 1 year for waterbirds and 3 years for vegetation</p>	<p>Environmental water has been delivered to Moodie Swamp each year between 2013–14 and 2017–18. No water was required in 2018–19 in 2019–20 natural flows partially filled the wetland.</p>	<p>High</p>	<p>High priority for Commonwealth Environmental water provided sufficient allocations available</p>	<p>Moderate</p>	

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21
Upper Broken Creek reach 1 Casey's Weir to Waggarandall Weir <ul style="list-style-type: none"> • Native fish – carp gudgeon, Murray cod, golden perch, Murray-Darling rainbow fish • Vegetation – box riparian vegetation, remnant plains grassy woodland, buloke trees and rigid water milfoil • Platypus • Common long-necked turtle • Birds – brolga, Australasian bittern 	Winter/spring low flows (June–Nov) Flows of 5 to 15 ML/day for around 30–70 days to maintain: pool habitat for native fish and waterbugs; access to food and habitat for platypus; and in-stream vegetation.	Annually with all levels of water availability	This flow was not met in 2013–14 and was partially met between 2014-15 and 2018-19. The flow was not met in 2019-20	High	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	High
	Summer/autumn fresh (Dec–May) Up to 100 ML/day for around 10 days to maintain water quality, particularly dissolved oxygen levels in refuge pools.	Annually with all levels of water availability except Very Dry	No historic information is available. In 2018–19 and 2019–20 no water quality issues were identified that required the delivery of this fresh.	High	High priority for Commonwealth environmental water if required	High
	Summer/autumn low flows (Dec–May) Flow of 1–8 ML/day for around 60–120 days to maintain: pool habitat for native fish and waterbugs; access to food and habitat for platypus; and in-stream vegetation.	Annually with all levels of water availability	This flow was not met in 2013–14 and was partially met between 2014-15 and 2017–18. The flow was not met in 2018-19 and 2019-20.	High	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	High
Broken River Reach 1 <ul style="list-style-type: none"> • Native fish - Murray cod, golden perch, silver perch, Murray-Darling rainbow fish, Macquarie perch, river black fish and mountain galaxias • Vegetation – eel grass, common reed and water ribbon 	Baseflow (all year) Flows of 5-25 ML/day for around 40–100 days to provide diverse habitat (riffles, slackwater, pools) for native fish, aquatic plants, platypus and waterbugs; support in-stream and fringing aquatic plants; and prevent terrestrial plants growing on the river bed.	Annually with all levels of water availability	Natural flows and consumptive water have met/partially met this flow target since 2010-11, except in 2019–20 when banked water was used in addition to operational flows. In accordance with the Broken System BE, between May and December 2019 the GB CMA and GMW agreed to reduce the passing flow requirement below Lake Nillahcootie from 30 ML/day or natural to 15 ML/day or natural and banked inflows above 15 ML/day. This action was undertaken to ensure sufficient water was available to maintain minimum baseflow requirements in the Broken River throughout the season. A total of 1425 ML of water was banked.	Moderate	May be met by other means	Moderate
	Summer/autumn fresh (Dec–May). 400–500 ML/day for 2 to 5 days with rates of rise and fall and a base flow of 30 ML/day to: maintain aquatic vegetation; provide native fish passage; scour sediments from hard surfaces to increase productivity and biofilms; and provide flow cues for native fish breeding and migration.	Annually with all levels of water availability except Very Dry	This target had not been met until 2017–18 when it was achieved by natural flows. In 2018-19 it as partially met when VEWH water was added to operational flows. This demand was partially met in 2019–20 from unregulated flows	Moderate	May be met by other means	Moderate

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands	
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21	
<p>Ovens River</p> <p><i>reach 1 immediately below Lake Buffalo on the Ovens River; reach 2 immediately below Lake William Hovell on the King River; reach 4 Ovens River from the confluence of the Buffalo River to the confluence of the King River; reach 5 Ovens River downstream of the confluence of the King River to the Murray River; and Mullinmur wetland downstream of Wangaratta.</i></p> <ul style="list-style-type: none"> • Native fish – Murray cod, trout cod, golden perch, Macquarie perch and eel tailed catfish • Frogs – giant bullfrog and growling grass frog • Waterbirds – egrets, herons, cormorants and bitterns • Vegetation – river red gum forests and woodlands 	<p>Up to the total Commonwealth environmental water entitlement of 103 ML per year (50 ML from Lake William Hovell and 53 ML from Lake Buffalo) to contribute to in-stream flows within the Ovens, Kings and Buffalo rivers, for example:</p> <ul style="list-style-type: none"> • Pulsed autumn fresh in conjunction with a bulk water transfer from Lake Buffalo to scour biofilms and maintain macroinvertebrate assemblage. • Increased summer/autumn baseflows if bulk water transfer is not available to improve flow variability and ensure connectivity between pools and riffles. 	<p>Annually with all levels of water availability</p>	<p>In 2014–15, 2015–16, 2017–18 and 2018–19 Commonwealth environmental water was released to supplement in-stream baseflows in the Buffalo and Ovens River.</p> <p>In all years Commonwealth environmental water was released to supplement in-stream baseflows in the King River.</p> <p>In 2011-12, 2012–13, 2013–14, 2016–17 and 2019-20 environmental water was delivered as part of a bulk release drawdown provided by Goulburn-Murray Water.</p>	<p>Moderate</p>	<p>High priority for Commonwealth environmental water, with releases to combine with natural or operational deliveries</p>	<p>Moderate</p>	
	<p>Autumn fresh (March/April)</p> <p>>430 ML/day for 3 days in reaches 1 and 4, and 130–260 ML/day in reach 5 to: achieve connectivity between pools and stimulate native fish movement; improve water quality by mixing pools; provide small variations in river levels and flow to flush sediment from hard surfaces and scour biofilm; and maintain waterbug habitat.</p>						<p>Summer/autumn low flow (Dec–May)</p> <p>Provide a small increase in flow variability to support water quality, provide connections between pools and the maintenance of waterbug habitat.</p>
	<p>Up to a total of 20 ML (from Lake Buffalo) of Commonwealth environmental water to contribute to Mullinmur wetland summer top-up (pumping) (Nov–Feb)</p> <p>Delivery to maintain water level, and to support aquatic vegetation and habitat for native eel-tailed catfish.</p>						

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21
<p>Campaspe River reach 2 Eppalock to Campaspe Weir; reach 3 Campaspe Weir to Campaspe Siphon at Rochester; and reach 4 Campaspe Siphon to River Murray)</p> <ul style="list-style-type: none"> • Native fish - Murray cod, silver perch, golden perch, Murray-Darling rainbow fish and flat headed gudgeon • Platypus, native water rats (rakali), turtles and frogs • Bank and instream vegetation, especially mature river red gum trees that support terrestrial fauna, including the swift parrot and squirrel glider. • During the past three years very high volumes of intervalley transfer water has impacted on the planned deliver of environmental water and this may continue during 2020–21 if dry conditions continue. 	<p>Summer/autumn low flow (Dec-May)</p> <p>10–50 ML/day to: maintain slackwater habitat for zooplankton and native fish; promote the growth of biofilms for water bugs and native fish; maintain water quality in deep pools; allow platypus to move between pools; and maintain in-stream vegetation along the channel edges.</p>	<p>Annually with all levels of water availability</p>	<p>These flow components have been delivered every year since 2012–13.</p> <p>During dry conditions all flows are delivered at the lower end of the flow ranges.</p> <p>Since 2017–18, annual intervalley transfers have exceeded the recommended summer low flows and freshes.</p>	High	May be met by other means	High
	<p>Winter/spring reduced low flow (June-Nov)</p> <p>20–40 ML/day to maintain water quality and connectivity between pool refuges to: allow fish movement, facilitate male platypus movement during the breeding season; and provide habitat and food for female platypus prior to breeding.</p>	<p>Annually only in an extremely dry scenario</p>		High	May be met by other means	High
	<p>Winter/spring fresh (June-Nov)</p> <p>Up to 2 actions of 1 100–1 600 ML/day to maintain habitat connectivity for fish movement and possibly spawning; flush leaf litter to reduce the risk of blackwater events in summer; and maintain soil moisture for river red gum and woody shrubs</p>	<p>Annually, however with low water availability in extreme dry-dry scenarios the action is of lower priority</p>		Moderate	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	Moderate
	<p>Winter/spring increased low flow (June–Nov)</p> <p>70–200 ML/day to achieve the same objectives as for winter/spring low flows but with additional vegetation objectives. These include to: prevent terrestrial plants colonising lower sections of the banks; maintain soil water in the banks for river red gum and woody shrubs; and to help establish littoral vegetation.</p>	<p>Annually, however with low water availability in extreme dry-dry scenarios the action is of lower priority</p>		Moderate	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	Moderate
	<p>Summer/autumn fresh (Dec-May)</p> <p>Up to 3 freshes of 100–200 ML/day to: promote local movement of adult fish to access new habitat; wet submerged wood and flush fine silt and old biofilm to promote new biofilm growth and increase waterbug mass; and encourage movement of juvenile platypus to find other habitat. When conditions are favourable, a fish attraction flow may also be delivered.</p>	<p>Annually, however with low water availability in extreme dry-dry scenarios the action is of lower priority</p>		Moderate	May be met by other means	Moderate

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21
<p>Loddon River reach 4 Loddon Weir to Kerang Weir with en route benefit to reaches 1 to 3 storage reservoirs to Loddon Weir and to reach 5 downstream Kerang Weir.</p> <ul style="list-style-type: none"> • Native fish - river blackfish, Murray-Darling rainbow fish and golden perch • vegetation – cane grass, tangled lignum, black box and river red gum • platypus • Water rat (rakali) 	<p>Winter/spring low flow (continuous June–Nov) 50–100 ML/day to: increase water depth for habitat and dispersal of fish; platypus and native water rat; prevent fine sediment settling on hard surfaces; and prevent terrestrial plant growth in the river channel.</p>	<p>Annually with all levels of water availability</p>	<p>The winter low flow has been delivered in every year since 2012–13 except for 2016–17 when it was partially achieved due to natural flooding causing water to be delivered at a higher rate and longer duration.</p>	Moderate	May be met by other means	High
	<p>Winter/spring high flow (Aug–Nov) 450- 750 ML/day for 6–10 days once a year to: provide flows through flood runners; trigger native fish movement and breeding; flush organic matter from banks and benches to increase productivity and reduce the risk of hypoxic blackwater in summer; scour accumulated sediment in pools; and increase wetted area for growth of bank vegetation.</p>	<p>Annually with all levels of water availability</p>	<p>The winter fresh was delivered in 2012–13 and between 2016–17 and 2019–20; it was partially delivered in 2013–14 and 2015–16.</p>	High	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	Moderate
	<p>Summer/autumn low flows (continuous Dec–May) 25–50 ML/day to: maintain pool depth for waterbugs, fish, native water rats and aquatic plants; and provide continuous flows for water quality and bank vegetation.</p>	<p>Annually with all levels of water availability</p>	<p>The summer low flows have been delivered in every year since 2012–13.</p>	High	May be met by other means	High
	<p>Summer/autumn freshes (Dec-May) 50–100 ML/day for 3–4 days, up to 3 times/year to: flush fine sediment from hard surfaces; promote growth of fringing vegetation; reduce risk of hypoxic black water; and enable connectivity for fish and platypus movement.</p>	<p>Annually with all levels of water availability</p>	<p>The summer freshes have been delivered in every year since 2012–13, except in 2018–19 when it was partially achieved.</p>	Moderate	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	Moderate
	<p>Autumn high flow (March–May) 400 ML/day for 6–10 days, once a year, to trigger and facilitate upstream movement of golden perch, silver perch and Murray cod over one year of age and facilitate platypus dispersal.</p>	<p>Biannually with all levels of water availability except an extreme dry scenario</p>	<p>The autumn fresh has been partially achieved since 2013–14 and was fully delivered every year from 2017–18 and 2019–20.</p>	Low	May be met by other means	Low

Environmental assets	Indicative demand (for all sources of water in the system)		Watering History (from all sources of water)	2020-21		Implications for future demands
	Flow/Volume	Required Frequency (maximum dry interval)		Environmental demand for water	Potential Commonwealth environmental water contribution	Likely environmental demand in 2021-22 if watering occurred as planned in 2020-21
Serpentine Creek	Winter/spring low flow (June–Nov) 20–30 ML/day to: ensure depth to maintain biofilms and flow variability for bank vegetation; inundate exposed debris and vegetation to provide habitat for aquatic animals; maintain water quality by re-oxygenating pools; and maintain spawning habitat for native fish.	Annually with all levels of water availability	This flow was partially delivered in 2017–18 and not achieved in 2018–19 or 2019-20.	High	May be met by other means	High
	Winter/spring fresh (Aug–Nov) 40 ML/day for 2 days or 120-150 ML for 1 day once a year to: provide connectivity for fish and waterbug habitat; transport accumulated organic matter; and scour pools.	Annually with all levels of water availability	This fresh has been delivered every year since 2017–18.	Moderate	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	Moderate
	Summer/autumn low flows (Dec–May) 10–20 ML/day to: provide flow variability and prevent notching; ensure connectivity between pools for fish; re-oxygenate pools to maintain water quality; maintain platypus habitat; and maintain aquatic environment for instream aquatic vegetation.	Annually with all levels of water availability	This flow was not delivered in 2017–18 and 2018–19; It was fully delivered in 2019-20.	High	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	High
	Summer/autumn fresh (Dec–May) 30–40 ML/day for 1-3 days up to 4 times a year to: transport accumulated organic matter; maintain fringing vegetation and biofilms; and provide water to inundate benches and flush fine sediment.	Annually with all levels of water availability	These freshes were partially delivered in 2017–18 and 2018–19 and fully delivered in 2019-20.	Moderate	High priority for Commonwealth environmental water (likely to receive water even under a very low water resource availability)	Moderate
Wimmera System	Up to the total Commonwealth entitlement of 28 000 ML (low reliability water share) per year to contribute toward instream flows within the Wimmera River (baseflow and freshes), to support native riparian vegetation, native fish and waterbugs, and improve connectivity and water quality.	Annual	In 2016–17 the Commonwealth received its first and only allocation of 14 280 ML against this entitlement. Through careful management and carryover this water was progressively used (alongside VEW water) throughout 2017 to early 2020 to support baseflows in the Wimmera system.	Critical	Low. The Commonwealth has no allocations or carryover currently available in the Wimmera. It will take significant inflows under a wet or very wet scenario before water becomes available to use	Critical

Key - potential watering in 2020-21

- High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)
- Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate - high water resource availability); or water demand likely to be met via other means
- Low priority for Commonwealth environmental watering (under high - very high water resource availability)
- Unable to provide Commonwealth water because of constraints or insufficient water

Key - environmental demands

- Critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
- High demand for water i.e. needed in that particular year
- Moderate demand for water i.e. water needed that particular year and/or next
- Low demand for water i.e. water generally not needed that particular year
- Very low demand for water i.e. water generally not needed that particular year or the following year

Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime

3.11.5 Water delivery in 2020–21

In the northern Victorian rivers, the delivery of water for the environment in 2020-21 is contingent upon the volume of holdings and the available allocations for each catchment. Consistent with the demands and purpose identified in Table 3, and as water for the environment becomes available, the CEWO is considering supplying water for the environment to contribute to:

- baseflows and freshes in each river, as well as off channel wetland actions that support a range of environmental outcomes for plants and animals
- flows that are coordinated across the Southern-connected Basin, when conditions are conducive, to achieve identified ecological outcomes, for example, golden and silver perch migration
- enhancing ecological benefit from natural flows and when possible, intervalley transfer flows, for example, adding water to the peak or during the recession of the flow.

As in previous years, the use of Commonwealth, Victorian and The Living Murray water will be adaptively managed together throughout 2020-21, in response to changing water resource availability and environmental conditions and demands.

3.11.6 Monitoring and Lessons learned

(a) Monitoring

The CEWO's [Long Term Intervention Monitoring Project \(LTIM\)](#) in the Goulburn River has identified a number of key environmental outcomes associated with the use of environmental water in the Goulburn River over the period 2014-15 to 2018-19. This work is being continued through the CEWO's [Monitoring, Evaluation and Research \(MER\)](#) program from 2019-20 to 2021-22. Both LTIM and MER complement the [Victorian Environmental Flow Monitoring Assessment Program \(VEFMAP\)](#), which examines the effect of water for the environment along 13 Victorian Rivers.

(b) Lessons learned

Outcomes from monitoring and lessons learned in previous years are a critical component for the effective and efficient use of Commonwealth water for the environment. These learnings are incorporated into the way environmental water is managed. Key findings from the LTIM (Webb et al. 2020) and VEFMAP (VEFMAP 2018) projects are summarised in **Table 5**.

Table 5: Key outcomes and lessons learned in Victorian Rivers

Theme	Outcomes and lesson learned
Native fish	<p><i>Goulburn River</i></p> <ul style="list-style-type: none"> • Improved habitat for larger native fish by providing flows that increase the depth and area of the larger pools where they live. • Golden perch spawning may occur after higher flows when water temperature is over 18°C. • Improved habitat for small-bodied fish with flows that increase areas of slow-flowing water. • Higher autumn flows can support upstream movement of golden and silver perch from the Murray River into the Goulburn and Campaspe Rivers. • Spawning by endangered trout cod in the last three years (2017–2019), shows that breeding populations exist in the river. • Although recruitment for golden perch is low, the Goulburn River is a source of fish for the Murray River.

Theme	Outcomes and lesson learned
	<p><i>Campaspe</i></p> <ul style="list-style-type: none"> Murray River rainbow fish, previously thought lost to the Campaspe system, observed at many sites and in abundance downstream of Elmore in reach 2. Good numbers of Murray cod young-of-year. This may be a result of the 2019 winter high flow event, or reduced impact of intervalley transfers, due to smaller magnitude compared to previous years. <p><i>Loddon</i></p> <ul style="list-style-type: none"> Combined Pyramid-Loddon spring fresh enhanced fish movement and populations in the Loddon River and Pyramid Creek. <p><i>Wimmera</i></p> <ul style="list-style-type: none"> Fish monitoring in autumn 2018 showed that populations of small-bodied native fish have been maintained in all reaches of the Wimmera catchment that received environmental flows. <p><i>Lower Broken Creek</i></p> <ul style="list-style-type: none"> the delivery of minimum low flows during the off-irrigation season provided habitat and instream refuge areas, especially important for young-of-year fish and for fish movement when fish ladders can remain open.
Macroinvertebrates	<p><i>Goulburn</i></p> <ul style="list-style-type: none"> Improved habitat for large water bugs (insects, snails, shrimp) with flows that increase areas of slow-flowing water. Increased habitat for populations of prawns during high winter flows, providing food for fish during spring.
Connectivity	<p><i>Goulburn</i></p> <ul style="list-style-type: none"> Increased food (organic carbon) availability for fish and large water bugs by providing high flows in winter and spring that maintain a healthy balance between the organic carbon that is produced and consumed in the river. Stream metabolism (the amounts of carbon created and consumed each day) increases with increasing in-channel flows up to around 4 000 ML/d. This represents a benefit to the total food resources produced for fish and other organisms, especially at small flow increases. However, it is still suggested that larger flows that inundate flood runners and parts of the floodplain would provide even greater benefits.
Vegetation	<p><i>Goulburn</i></p> <ul style="list-style-type: none"> Increased plant cover on the river bank by providing flows that increase soil moisture, reduce erosion, and provide areas of low flow that favour seed and sediment deposition and plant establishment. Renewal of bank and in-channel vegetation following deposition of sediment and seed when river banks are submerged during high flows over winter. Very high intervalley transfer flows affected the presence of shallow water near the banks, potentially reducing the availability of suitable habitat for juvenile fish; it can also drown lower bank vegetation.

Theme	Outcomes and lesson learned
	<p><i>Lower Broken Creek</i></p> <ul style="list-style-type: none"> the minimum low flows over winter retained water in the main creek channel and inundated the instream aquatic plants present.
Bank condition	<p><i>Goulburn</i></p> <ul style="list-style-type: none"> Current environmental flows do not cause more erosion than would occur under natural flows Notching of the lower bank has been observed where high IVT flows were delivered at constant levels over summer.

3.11.7 Bibliography

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